CHEMICAL AND LIFE SCIENCE ENGINEERING, BACHELOR OF SCIENCE (B.S.) WITH A CONCENTRATION IN LIFE SCIENCE ENGINEERING

The department offers a Bachelor of Science in Chemical and Life Science Engineering, and includes a chemical engineering concentration and a life science engineering concentration. Each student must choose the desired concentration upon initial registration.

As part of the B.S. degree in chemical and life science engineering, all students complete an approved internship or cooperative education experience.

Student learning outcomes

Upon completing this program, students will have the following knowledge, skills, behaviors, and/or attitudes:

1. An ability to identify, formulate and solve complex engineering problems by applying principles of engineering, science and mathematics
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety and welfare, as well as global, cultural, social, environmental and economic factors
3. An ability to communicate effectively with a range of audiences
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental and societal contexts
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks and meet objectives
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies
8. An understanding of the hazards associated with physical, chemical and/or biological processes

Special requirements

Students must receive a grade of C in all engineering courses in order to graduate. Minimum grades of C in CLSE 115, CLSE 201 and CLSE 202 are required before students may take additional CLSE courses. After passing CLSE 202 with a minimum grade of C, students are allowed to continue with one D grade in any CLSE course. They must retake that course in order to graduate, but may continue taking other CLSE courses. Students are not allowed to continue with two grades of D in CLSE courses and must successfully retake at least one of those courses with a minimum grade of C to take additional 300- and 400-level CLSE courses.

Degree requirements for Chemical and Life Science Engineering, Bachelor of Science (B.S.) with a concentration in life science engineering

Course	Title	Hours
General education (https://bulletin.vcu.edu/undergraduate/undergraduate-study/general-education-curriculum/)		
Select 30 credits of general education courses in consultation with an adviser.		30
Major requirements		
• Major core requirements		
CLSE 101	Introduction to Engineering	3
CLSE 115	Introduction to Programming for Chemical and Life Science Engineering	4
CLSE 201	Chemical Engineering Fundamentals I: Material Balances	4
CLSE 202	Chemical Engineering Fundamentals II: Energy Balances and Engineering Thermodynamics	4
CLSE 301	Transport Phenomena I	3
CLSE 302	Transport Phenomena II	4
CLSE 305	Thermodynamics of Phase Equilibria and Chemical Reactions	3
CLSE 312	Chemical Reaction Engineering	3
CLSE 320	Instrumentation Laboratory	3
CLSE 402	Senior Design Studio I (Laboratory/Project Time)	2
CLSE 403	Senior Design Studio II (Laboratory/Project Time)	2
CLSE 409	Process Control in Chemical and Life Science Engineering	3
CLSE 440	Unit Operations Laboratory	3
ENGR 395	Professional Development	1
ENGR 402	Senior Design Studio (Seminar)	1
ENGR 403	Senior Design Studio (Seminar)	1
• Additional major requirements		
Approved internship or cooperative education experience		0
ENGR 296	Part-time Internship Experience	
or ENGR 396	Internship Experience	
or ENGR 398	Cooperative Education Experience	
Review of internship or cooperative education experience		0
ENGR 496	Internship Review	
or ENGR 498	Review of Cooperative Education Experience	
• Major electives		
Select engineering electives as described below.		9
Ancillary requirements		
BIOL 151 & BIOZ 151	Introduction to Biological Sciences I and Introduction to Biological Science Laboratory I	4
BIOL 152	Introduction to Biological Sciences II	3
CHEM 101	General Chemistry I (satisfies general education BOK for natural sciences and AOI for scientific and logical reasoning)	3
CHEZ 101	General Chemistry Laboratory I	1

CHEM 102 & CHEZ 102	General Chemistry II and General Chemistry Laboratory II	4
CHEM 301 & CHEZ 301	Organic Chemistry and Organic Chemistry Laboratory I	5
CHEM 302 & CHEZ 302	Organic Chemistry and Organic Chemistry Laboratory II	5
CHEM 403	Biochemistry I	3
ECON 205	The Economics of Product Development and Markets (satisfies general education BOK for social/ behavioral sciences and AOI for global perspectives)	3
MATH 200	Calculus with Analytic Geometry I (satisfies general education quantitative foundations)	4
MATH 201	Calculus with Analytic Geometry II	4
MATH 301	Differential Equations	3
MATH 307	Multivariate Calculus	4
PHIL 201	Introduction to Ethics (satisfies general education BOK for humanities/fine arts and AOI for diversities in the human experience)	3
PHYS 207	University Physics I (satisfies general education BOK for natural sciences and AOI for scientific and logical reasoning)	5
PHYS 208	University Physics II	5
STAT 441	Applied Statistics for Engineers and Scientists	3
Total Hours		**127**

The minimum number of credit hours required for this degree is 127.

Engineering electives

Engineering electives are satisfied by completing courses that meet all of the following criteria:

1. 300-level or greater
2. Offered in the College of Engineering (CLSE, CMSC, EGMN, EGRB, EGRC, EGRE, EGRM, EGRN or ENGR)
3. Offered for three or more credit hours
4. Not otherwise required for the major by the effective Bulletin

Note: A minimum of four credits of ENGR 497 must be completed to satisfy an engineering elective requirement. Other courses may be used to satisfy the requirements with prior written approval from the department chair.

What follows is a sample plan that meets the prescribed requirements within a four-year course of study at VCU. Please contact your adviser before beginning course work toward a degree.

Freshman year		
Fall semester		**Hours**
CHEM 101	General Chemistry I (satisfies general education BOK for natural sciences and AOI for scientific and logical reasoning)	3
CHEZ 101	General Chemistry Laboratory I	1
CLSE 101	Introduction to Engineering	3
MATH 200	Calculus with Analytic Geometry I (satisfies general education quantitative foundations)	4
UNIV 111 Play course video for Introduction to Focused Inquiry: Investigation and Communication	Introduction to Focused Inquiry: Investigation and Communication (satisfies general education UNIV foundations)	3
	Term Hours:	**14**
Spring semester		
CHEM 102 & CHEZ 102	General Chemistry II and General Chemistry Laboratory II	4
CLSE 115	Introduction to Programming for Chemical and Life Science Engineering	4
ENGR 395	Professional Development	1
MATH 201	Calculus with Analytic Geometry II	4
UNIV 112 Play course video for Focused Inquiry II	Focused Inquiry II (satisfies general education UNIV foundations)	3
	Term Hours:	**16**
Sophomore year		
Fall semester		
CHEM 301 & CHEZ 301	Organic Chemistry and Organic Chemistry Laboratory I	5
CLSE 201	Chemical Engineering Fundamentals I: Material Balances	4
MATH 301	Differential Equations	3
PHYS 207	University Physics I (satisfies general education BOK for natural sciences and AOI for scientific and logical reasoning)	5
	Term Hours:	**17**
Spring semester		
CHEM 302 & CHEZ 302	Organic Chemistry and Organic Chemistry Laboratory II	5
CLSE 202	Chemical Engineering Fundamentals II: Energy Balances and Engineering Thermodynamics	4
MATH 307	Multivariate Calculus	4
PHYS 208	University Physics II	5
	Term Hours:	**18**
Summer semester		
ENGR 396 or ENGR 398	Internship Experience or Cooperative Education Experience	0
	Term Hours:	**0**
Junior year		
Fall semester		
BIOL 151 & BIOZ 151	Introduction to Biological Sciences I and Introduction to Biological Science Laboratory I	4

CLSE 301	Transport Phenomena I	3
CLSE 305	Thermodynamics of Phase Equilibria and Chemical Reactions	3
ECON 205	The Economics of Product Development and Markets (satisfies general education BOK for social/behavioral sciences and AOI for global perspectives)	3
UNIV 200	Advanced Focused Inquiry: Literacies, Research and Communication (satisfies general education UNIV foundations)	3
	Term Hours:	**16**
Spring semester		
BIOL 152	Introduction to Biological Sciences II	3
CLSE 302	Transport Phenomena II	4
CLSE 312	Chemical Reaction Engineering	3
CLSE 320	Instrumentation Laboratory	3
STAT 441	Applied Statistics for Engineers and Scientists	3
	Term Hours:	**16**
Senior year		
Fall semester		
CHEM 403	Biochemistry I	3
CLSE 402	Senior Design Studio I (Laboratory/Project Time)	2
CLSE 409	Process Control in Chemical and Life Science Engineering	3
CLSE 440	Unit Operations Laboratory	3
ENGR 402	Senior Design Studio (Seminar)	1
ENGR 496 or ENGR 498	Internship Review or Review of Cooperative Education Experience	0
PHIL 201	Introduction to Ethics (satisfies general education BOK for humanities/fine arts and AOI for diversities in the human experience)	3
	Term Hours:	**15**
Spring semester		
CLSE 403	Senior Design Studio II (Laboratory/Project Time)	2
ENGR 403	Senior Design Studio (Seminar)	1
General education course		3
Engineering electives (300+ level)		9
	Term Hours:	**15**
	Total Hours:	**127**

The minimum number of credit hours required for this degree is 127.

Accelerated B.S. and M.S.

The accelerated B.S. and M.S. program allows qualified students to earn both the B.S. in Chemical and Life Science Engineering and the M.S. in Biomedical Engineering in a minimum of five years by completing approved graduate courses during the senior year of their undergraduate program. Students in the program may count up to twelve hours of graduate courses toward both the B.S. and M.S. degrees. Thus, the two degrees may be earned with a minimum of 144 credits rather than the 156 credits necessary if the two degrees are pursued separately.

Students holding these degrees will have a head start for pursuing careers in industry or continuing in an academic setting. The M.S. degree provides formal research experience and can lead to expanded job opportunities, greater potential for job advancement and higher starting salaries.

Entrance to the accelerated program

Interested undergraduate students should consult with their adviser as early as possible to receive specific information about the accelerated program, determine academic eligibility and submit (no later than two semesters prior to graduating with a baccalaureate degree, that is, before the end of the spring semester of their junior year) an Accelerated Program Declaration Form to be approved by the graduate program director. Limited spaces may be available in the accelerated program. Academically qualified students may not receive approval if capacity has been reached.

Minimum qualifications for entrance to this accelerated program include an overall GPA of 3.0. Additionally, for students pursuing the thesis option of the master's program, a letter of endorsement from a prospective thesis adviser from the biomedical engineering faculty must accompany the application. Students who are interested in the accelerated program should consult with the faculty adviser to the biomedical engineering graduate program. Successful applicants would enter the program in the fall semester of their senior year.

Once enrolled in the accelerated program, students must meet the standards of performance applicable to graduate students as described in the "**Satisfactory academic progress**" section of the Graduate Bulletin, including maintaining a 3.0 GPA. Guidance to students admitted to the accelerated program is provided by both the CLSE undergraduate program director and the BME graduate program director.

Admission to the graduate program

Entrance to the accelerated program enables the student to take the approved shared courses that will apply to the undergraduate and graduate degrees. However, entry into an accelerated program via an approved Accelerated Program Declaration Form does not constitute application or admission into the graduate program. Admission to the graduate program requires a separate step that occurs through a formal application to the master's program, which is submitted through Graduate Admissions no later than a semester prior to graduation with the baccalaureate degree, that is, before the end of the fall semester of the senior year. In order to continue pursuing the master's degree after the baccalaureate degree is conferred, accelerated students must follow the admission to graduate study requirements outlined in the VCU Bulletin. One reference letter from a chemical and life science engineering faculty member must accompany the application.

Degree requirements

The Bachelor of Science in Chemical and Life Science Engineering degree will be awarded upon completion of a minimum of 126 credits and the satisfactory completion of all undergraduate degree requirements as stated in the Undergraduate Bulletin.

A maximum of 12 graduate credits of 500-level graduate courses may be taken prior to completion of the baccalaureate degree. These graduate credits will be utilized to fulfill engineering electives course requirements for the undergraduate degree. These courses are shared

credits with the graduate program, meaning that they will be applied to both undergraduate and graduate degree requirements.

The graduate courses that may be taken as an undergraduate, once a student is admitted to the program, must be approved by the adviser or graduate program director and include 500-level courses from the following subject areas: EGMN, EGRM, ENGR, EGRN, EGRB, EGRE, CLSE, CMSC, PHYS, MATH, NANO, CHEM, BIOL, GRAD, LFSC, INNO and OVPR.

Recommended plan of study for thesis master's

What follows is the recommended plan of study for students interested in the accelerated program beginning in the fall of the senior year prior to admission to the accelerated program in the senior year.

Course	Title	Hours
Senior year		
Fall semester		
CLSE 402	Senior Design Studio I (Laboratory/ Project Time)	2
CLSE 409	Process Control in Chemical and Life Science Engineering	3
CLSE 440	Unit Operations Laboratory	3
ENGR 402	Senior Design Studio (Seminar)	1
ENGR 496	Internship Review	0
or ENGR 498	Review of Cooperative Education Experience	
PHIL 201	Introduction to Ethics	3
Approved technical electives (Consider BME courses for accelerated pathway)		3
Term Hours:		15
Spring semester		
CLSE 403	Senior Design Studio II (Laboratory/ Project Time)	2
ENGR 403	Senior Design Studio (Seminar)	1
General education course		3
Approved technical electives (Consider BME courses for accelerated pathway)		9
Term Hours:		15
Fifth year		
Fall semester		
EGRB 601	Numerical Methods and Modeling in Biomedical Engineering	4
EGRB 697	Directed Research in Biomedical Engineering	3
Open elective [1]		3
Term Hours:		10
Spring semester		
EGRB 602	Biomedical Engineering Systems Physiology	4
EGRB 690	Biomedical Engineering Research Seminar	1
EGRB 697	Directed Research in Biomedical Engineering	4
Term Hours:		9

[1] EGRB, EGMN, ENGR, PHYS, MATH, CMSC, BIOL, PHIS or BIOC at 500-level or above.

Recommended plan of study for non-thesis master's

What follows is the recommended plan of study for students interested in the accelerated program beginning in the fall of the senior year prior to admission to the accelerated program in the senior year.

Course	Title	Hours
Senior year		
Fall semester		
CLSE 402	Senior Design Studio I (Laboratory/ Project Time)	2
CLSE 409	Process Control in Chemical and Life Science Engineering	3
CLSE 440	Unit Operations Laboratory	3
ENGR 402	Senior Design Studio (Seminar)	1
ENGR 496	Internship Review	0
or ENGR 498	Review of Cooperative Education Experience	
PHIL 201	Introduction to Ethics	3
Approved technical electives (Consider BME courses for accelerated pathway)		3
Term Hours:		15
Spring semester		
CLSE 403	Senior Design Studio II (Laboratory/ Project Time)	2
ENGR 403	Senior Design Studio (Seminar)	1
General education course		3
Approved technical electives (Consider BME courses for accelerated pathway)		9
Term Hours:		15
Fifth year		
Fall semester		
EGRB 601	Numerical Methods and Modeling in Biomedical Engineering	4
EGRB technical elective (500-level or above)		3
Open elective [1]		6
Term Hours:		13
Spring semester		
EGRB 602	Biomedical Engineering Systems Physiology	4
EGRB 690	Biomedical Engineering Research Seminar	1
Open elective [1]		6
Term Hours:		11

[1] EGRB, EGMN, ENGR, PHYS, MATH, CMSC, BIOL, PHIS or BIOC at 500-level or above.

Accelerated B.S. and M.S.

The accelerated B.S. and M.S. program allows qualified students to earn both the B.S. in Chemical and Life Science Engineering and the M.S. in Computer Science in a minimum of five years by completing approved

graduate courses during the senior year of their undergraduate program. Students in the program may count up to twelve hours of graduate courses toward both the B.S. and M.S. degrees. Thus, the two degrees may be earned with a minimum of 144 credits rather than the 156 credits necessary if the two degrees are pursued separately.

Students holding these degrees will have a head start for pursuing careers in industry or continuing in an academic setting. The M.S. degree provides formal research experience and can lead to expanded job opportunities, greater potential for job advancement and higher starting salaries.

Entrance to the accelerated program

Interested undergraduate students should consult with their adviser as early as possible (sophomore year is recommended) to receive specific information about the accelerated program, determine academic eligibility and submit (no later than two semesters prior to graduating with a baccalaureate degree, that is, before the end of the spring semester of their junior year) an Accelerated Program Declaration Form to be approved by the graduate program director. Limited spaces may be available in the accelerated program. Academically qualified students may not receive approval if capacity has been reached.

Minimum qualifications for entrance to any accelerated program include a minimum overall GPA of 3.0. For acceptance into this accelerated pathway, students must have completed CMSC 257, CMSC 311, CMSC 355, and CMSC 401 courses with a GPA of at least 3.4. Students who are interested in the accelerated program should consult with the faculty adviser to the graduate program. Successful applicants would enter the program in the following semester after graduation with the bachelor's degree.

Once enrolled in the accelerated program, students must meet the standards of performance applicable to graduate students as described in the "Satisfactory academic progress (https://bulletin.vcu.edu/academic-regs/grad/satisfactory-academic-progress/)" section of the Graduate Bulletin, including maintaining a 3.0 GPA. Guidance to students admitted to the accelerated program is provided by both the undergraduate graduate program adviser and the graduate program director.

Admission to the graduate program

Entrance to the accelerated program enables the student to take the approved shared courses that will apply to the undergraduate and graduate degrees. However, entry into an accelerated program via an approved Accelerated Program Declaration Form does not constitute application or admission into the graduate program. Admission to the graduate program requires a separate step that occurs through a formal application to the master's program, which is submitted through Graduate Admissions no later than a semester prior to graduation with the baccalaureate degree, that is, before the end of the fall semester of the senior year. In order to continue pursuing the master's degree after the baccalaureate degree is conferred, accelerated students must follow the admission to graduate study requirements outlined in the VCU Bulletin. One reference letter from a chemical and life science engineering faculty member must accompany the application. The GRE is waived for admission to the program.

Degree requirements

The Bachelor of Science in Chemical and Life Science Engineering degree will be awarded upon completion of a minimum of 126 credits and the satisfactory completion of all undergraduate degree requirements as stated in the Undergraduate Bulletin.

For students entering the non-thesis option, a maximum of 12 graduate credits may be taken prior to the completion of the baccalaureate degree. For students entering the thesis option, a maximum of 12 graduate credits may be taken. These graduate credits will count as open or technical elective credits for the undergraduate degree. These courses are shared credits with the graduate program, meaning that they will be applied to both undergraduate and graduate degree requirements.

The graduate courses that may be taken as an undergraduate, once a student is admitted to the program, must be approved by the adviser or graduate program director and include 500-level courses from the following subject areas: EGMN, EGRM, ENGR, EGRN, EGRB, EGRE, CLSE, CMSC, PHYS, MATH, NANO, CHEM, BIOL, GRAD, LFSC, INNO and OVPR.

Recommended course sequence/plan of study for students pursuing a thesis master's

What follows is the recommended plan of study for students interested in the accelerated program beginning in the fall of the junior year prior to admission to the accelerated program in the senior year.

Course	Title	Hours
Senior year		
Fall semester		
CLSE 402	Senior Design Studio I (Laboratory/ Project Time)	2
CLSE 409	Process Control in Chemical and Life Science Engineering	3
CLSE 440	Unit Operations Laboratory	3
ENGR 402	Senior Design Studio (Seminar)	1
ENGR 496	Internship Review	0
or ENGR 498	Review of Cooperative Education Experience	
PHIL 201	Introduction to Ethics	3
Technical elective (consider CS course for accelerated pathway)		3
Term Hours:		15
Spring semester		
CLSE 403	Senior Design Studio II (Laboratory/ Project Time)	2
ENGR 403	Senior Design Studio (Seminar)	1
General education course		3
Technical electives (consider CS courses for accelerated pathway)		9
Term Hours:		15
Fifth year		
Fall semester		
CMSC 697	Directed Research	3
M.S. foundational area courses (theory and systems) [1]		6
Term Hours:		9
Spring semester		
CMSC 697	Directed Research	6
M.S. foundational area course (applied) [1]		3
Term Hours:		9

[1]

See the Graduate Bulletin for the list of theory, systems and applied foundational courses.

Recommended course sequence/plan of study for students pursuing a non-thesis master's

What follows is the recommended plan of study for students interested in the accelerated program beginning in the fall of the junior year prior to admission to the accelerated program in the senior year.

Course	Title	Hours
Senior year		
Fall semester		
CLSE 402	Senior Design Studio I (Laboratory/ Project Time)	2
CLSE 409	Process Control in Chemical and Life Science Engineering	3
CLSE 440	Unit Operations Laboratory	3
ENGR 402	Senior Design Studio (Seminar)	1
ENGR 496	Internship Review	0
or ENGR 498	Review of Cooperative Education Experience	
PHIL 201	Introduction to Ethics	3
Technical elective (consider CS course for accelerated pathway)		3
Term Hours:		15
Spring semester		
CLSE 403	Senior Design Studio II (Laboratory/ Project Time)	2
ENGR 403	Senior Design Studio (Seminar)	1
General education course		3
Technical electives (consider CS courses for accelerated pathway)		9
Term Hours:		15
Fifth year		
Fall semester		
M.S. foundational area courses (theory and systems) [1]		9
Term Hours:		9
Spring semester		
M.S. foundational area course (applied) [1]		9
Term Hours:		9

[1]

See the Graduate Bulletin for the list of theory, systems, and applied foundational area courses.

Accelerated B.S. and M.S.

The accelerated B.S.-to-M.S. program allows qualified students to earn both the B.S. in Chemical and Life Science Engineering and the M.S. in Engineering, concentration in aerospace engineering; chemical and life science engineering; electrical and computer engineering; engineering management; environmental and sustainable engineering; rehabilitation engineering; systems engineering; or tissue engineering and regenerative medicine in a minimum of five years by completing approved graduate courses during the senior year of their undergraduate program. Students in the program may count up to six hours (non-thesis option) or 12 hours (thesis option) of graduate courses toward both the B.S. and M.S. degrees.

Students holding these degrees will have a head start for pursuing careers in industry or continuing in academia. The M.S. degree provides formal research experience and can lead to expanded job opportunities, greater potential for job advancement and higher starting salaries.

Entrance to the accelerated program

Interested undergraduate students should consult with their adviser as early as possible to receive specific information about the accelerated program, determine academic eligibility and submit (no later than two semesters prior to graduating with a baccalaureate degree, that is, before the end of the spring semester of their junior year) an Accelerated Program Declaration Form to be approved by the graduate program director. Limited spaces may be available in the accelerated program. Academically qualified students may not receive approval if capacity has been reached.

Minimum qualifications for entrance to any accelerated program include completion of 95 undergraduate credit hours and a minimum overall GPA of 3.0. Students who are interested in the accelerated program should consult with the faculty adviser to the graduate program before they have completed 95 credits. Successful applicants would enter the program in the following semester after graduation with the bachelor's degree.

Once enrolled in the accelerated program, students must meet the standards of performance applicable to graduate students as described in the "Satisfactory academic progress (https://bulletin.vcu.edu/academic-regs/grad/satisfactory-academic-progress/)" section of the Graduate Bulletin, including maintaining a 3.0 GPA. Guidance to students admitted to the accelerated program is provided by both the undergraduate graduate program adviser and the graduate program director.

Admission to the graduate program

Entrance to the accelerated program enables the student to take the approved shared courses that will apply to the undergraduate and graduate degrees. However, entry into an accelerated program via an approved Accelerated Program Declaration Form does not constitute application or admission into the graduate program. Admission to the graduate program requires a separate step that occurs through a formal application to the master's program, which is submitted through Graduate Admissions no later than a semester prior to graduation with the baccalaureate degree, that is before the end of the fall semester of the senior year. In order to continue pursuing the master's degree after the baccalaureate degree is conferred, accelerated students must follow the admission to graduate study requirements outlined in the VCU Bulletin. The GRE and application fee is waived for admission to the program for all students. Additionally, for students pursuing the thesis option of the master's program, a letter of endorsement from a prospective thesis adviser from a faculty member in the relevant department may accompany the application.

Degree requirements

The Bachelor of Science in Chemical and Life Science Engineering will be awarded upon completion of all undergraduate degree requirements as stated in the Undergraduate Bulletin.

For students entering the non-thesis option, a maximum of six graduate credits may be taken prior to the completion of the baccalaureate degree. For students entering the thesis option, a maximum of 12 graduate

credits may be taken. These graduate credits will count as open or technical elective credits for the undergraduate degree. These courses are shared credits with the graduate program, meaning that they will be applied to both undergraduate and graduate degree requirements.

The graduate courses that may be taken as an undergraduate, once a student is admitted to the program, must be approved by the adviser or graduate program director and include 500-level courses from the following subject areas: EGMN, EGRM, ENGR, EGRN, EGRB, EGRE, CLSE, CMSC, PHYS, MATH, NANO, CHEM, BIOL, GRAD, LFSC, INNO and OVPR.

Curriculum requirements

Concentration in aerospace engineering

Thesis option

Course	Title	Hours
Required graduate-level coursework		
Engineering or other relevant graduate course work (including a minimum of 9 credit hours from 500-level or higher courses in EGRE, ENGR, EGRB, EGMN, CMSC, CLSE) approved by the advisory committee: This component allows the student to take courses in either engineering or science with approval of the student's adviser.		12
Concentration component		
EGMN 604	Mechanical and Nuclear Engineering Materials	3
EGMN 605	Mechanical and Nuclear Engineering Analysis	3
EGMN 606	Mechanical and Nuclear Engineering Continuum Mechanics	3
EGMN 607	Heat and Mass Transfer Theory and Applications	3
Directed research component		
This component emphasizes research directed toward completion of degree requirements under the direction of an adviser and advisory committee.		
EGMN 697	Directed Research in Mechanical and Nuclear Engineering	6
Total Hours		**30**

Non-thesis option

Course	Title	Hours
Required graduate-level coursework		
Engineering or other relevant graduate course work (including a minimum of 9 credit hours from 500-level or higher courses in EGRE, ENGR, EGRB, EGMN, CMSC, CLSE) approved by the adviser: This component allows the student to take courses in either engineering or science with approval of the student's adviser.		15
Concentration component		
EGMN 604	Mechanical and Nuclear Engineering Materials	3
EGMN 605	Mechanical and Nuclear Engineering Analysis	3
EGMN 606	Mechanical and Nuclear Engineering Continuum Mechanics	3
EGMN 607	Heat and Mass Transfer Theory and Applications	3
EGMN 661	Computational Fluid Dynamics	3
Total Hours		**30**

Concentration in chemical and life science engineering

Thesis option

Course	Title	Hours
Required graduate-level coursework		
Engineering or other relevant graduate course work (including a minimum of 6 credit hours from 500-level or higher courses in EGRE, ENGR, EGRB, EGMN, CMSC, CLSE, PESC) approved by the advisory committee: This component allows the student to take courses in either engineering or science with approval of the student's adviser.		9
Concentration component - CLSE course work		
CLSE 650	Quantitative Analysis in Chemical and Life Science Engineering	3
CLSE 654	Equilibrium Analysis in Chemical and Biological Systems	3
CLSE 655	Nonequilibrium Analysis in Chemical and Life Science Engineering	3
CLSE 656	Advanced Chemical Reaction Engineering	3
Choose additional CLSE course work at the 500 level or higher		3
Directed research		
Select six credit hours from the following:		6
CLSE 690	Research Seminar in Chemical and Life Science Engineering	
CLSE 697	Directed Research in Chemical and Life Science Engineering	
Total Hours		**30**

Non-thesis option

Course	Title	Hours
Required graduate-level coursework		
Engineering or other relevant graduate course work (including a minimum of 9 credit hours from 500-level or higher courses in EGRE, ENGR, EGRB, EGMN, CMSC, CLSE, PESC) approved by the adviser: This component allows the student to take courses in either engineering or science with approval of the student's adviser.		12
Concentration component - CLSE course work		
CLSE 650	Quantitative Analysis in Chemical and Life Science Engineering	3
CLSE 654	Equilibrium Analysis in Chemical and Biological Systems	3
CLSE 655	Nonequilibrium Analysis in Chemical and Life Science Engineering	3
CLSE 656	Advanced Chemical Reaction Engineering	3
Choose additional CLSE course work at the 500 level or higher		6
Total Hours		**30**

Concentration in electrical and computer engineering

Thesis option

Course	Title	Hours
Required graduate-level coursework		
Engineering or other relevant graduate course work (including a minimum of 9 credit hours from 500-level or higher courses in EGRE, ENGR, EGRB, EGMN, CMSC, CLSE) approved by the advisory committee: This component allows the student to take courses in either engineering or science with approval of the student's adviser.		12
Concentration component		
EGRE course work (EGRE 500-level or higher or courses approved by the advisory committee): This component allows the student to pursue a series of courses that focus on a specific field of engineering and serve as the student's primary engineering discipline.		12
Directed research component		
This component emphasizes research directed toward completion of degree requirements under the direction of an adviser and advisory committee.		
EGRE 697	Directed Research in Electrical and Computer Engineering	6
Total Hours		**30**

Non-thesis option

Course	Title	Hours
Required graduate-level coursework		
Engineering or other relevant graduate course work (including a minimum of 9 credit hours from 500-level or higher courses in EGRE, ENGR, EGRB, EGMN, CMSC, CLSE) approved by the adviser: This component allows the student to take courses in either engineering or science with approval of the student's adviser.		15
Concentration component		
EGRE course work (EGRE 500-level or higher or courses approved by the adviser): This component allows the student to pursue a series of courses that focus on a specific field of engineering and serve as the student's primary engineering discipline.		15
Total Hours		**30**

Concentration in engineering management

Course	Title	Hours
Required graduate-level coursework		
Engineering or other relevant graduate course work (including a minimum of 9 credit hours from 500-level or higher courses in EGRE, ENGR, EGRB, EGMN, CMSC, CLSE) approved by the adviser. This component allows the student to take courses in either engineering or science with approval of the student's adviser.		18
Concentration component		
EGMN 507	Law and Engineering	3
ENGR 601	Engineering Project Management	3
ENGR 602	Engineering Contracts and Effective Negotiations	3
ENGR 696	Engineering Products and Economic Considerations	3
Total Hours		**30**

Concentration in environmental and sustainable engineering

Thesis option

Course	Title	Hours
Required graduate-level coursework		
Engineering or other relevant graduate course work (including a minimum of 9 credit hours from 500-level or higher courses in EGRE, ENGR, EGRB, EGMN, CMSC, CLSE) approved by the advisory committee: This component allows the student to take courses in either engineering or science with approval of the student's adviser.		12
Concentration component		
CLSE 545	Water Essentials	3
CLSE 580	Sustainable Chemical Engineering	3
CLSE 650	Quantitative Analysis in Chemical and Life Science Engineering	3
CLSE 655	Nonequilibrium Analysis in Chemical and Life Science Engineering	3
Directed research component		
This component emphasizes research directed toward completion of degree requirements under the direction of an adviser and advisory committee.		
CLSE 697	Directed Research in Chemical and Life Science Engineering	6
Total Hours		**30**

Non-thesis option

Course	Title	Hours
Required graduate-level coursework		
Engineering or other relevant graduate course work (including a minimum of 9 credit hours from 500-level or higher courses in EGRE, ENGR, EGRB, EGMN, CMSC, CLSE) approved by the adviser: This component allows the student to take courses in either engineering or science with approval of the student's adviser.		18
Concentration component		
CLSE 545	Water Essentials	3
CLSE 580	Sustainable Chemical Engineering	3
CLSE 650	Quantitative Analysis in Chemical and Life Science Engineering	3
CLSE 655	Nonequilibrium Analysis in Chemical and Life Science Engineering	3
Total Hours		**30**

Concentration in rehabilitation engineering

Thesis option

Course	Title	Hours
Required graduate-level coursework		
Engineering or other relevant graduate course work (including a minimum of 6 credit hours from 500-level or higher courses in EGRE, ENGR, EGRB, EGMN, CMSC, CLSE) approved by the advisory committee: This component allows the student to take courses in either engineering or science with approval of the student's adviser.		8
Concentration component		
EGRB 520	Assistive Technology	3
EGRB 521	Human Factors Engineering	3
EGRB 523	Rehabilitation Engineering and Prostheses	3
EGRB 603	Biomedical Signal Processing	3
ANAT 610	Systems Neuroscience	4
Directed research		
EGRB 697	Directed Research in Biomedical Engineering	6
Total Hours		**30**

Non-thesis option

Course	Title	Hours
Required graduate-level coursework		
Engineering or other relevant graduate course work (including a minimum of 9 credit hours from 500-level or higher courses in EGRE, ENGR, EGRB, EGMN, CMSC, CLSE) approved by the adviser: This component allows the student to take courses in either engineering or science with approval of the student's adviser.		14
Concentration component		
EGRB 520	Assistive Technology	3
EGRB 521	Human Factors Engineering	3
EGRB 523	Rehabilitation Engineering and Prostheses	3
EGRB 603	Biomedical Signal Processing	3
ANAT 610	Systems Neuroscience	4
Total Hours		**30**

Concentration in systems engineering

Thesis option

Course	Title	Hours
Required graduate-level coursework		
Engineering or other relevant graduate course work (including a minimum of 9 credit hours from 500-level or higher courses in EGRE, ENGR, EGRB, EGMN, CMSC, CLSE) approved by the advisory committee: This component allows the student to take courses in either engineering or science with approval of the student's adviser.		12
Concentration component		
EGRE 510	Introduction to Internet of Things	3
EGRE 512	Intelligent Autonomous Systems	3
EGRE 513	Fundamentals of Modern Systems Engineering	3
EGRE 615	Systems Modeling	3
Directed research component		
This component emphasizes research directed toward completion of degree requirements under the direction of an adviser and advisory committee.		
EGRE 697	Directed Research in Electrical and Computer Engineering	6
Total Hours		**30**

Non-thesis option

Course	Title	Hours
Required graduate-level coursework		
Engineering or other relevant graduate course work (including a minimum of 9 credit hours from 500-level or higher courses in EGRE, ENGR, EGRB, EGMN, CMSC, CLSE) approved by the adviser: This component allows the student to take courses in either engineering or science with approval of the student's adviser.		18
Concentration component		
EGRE 510	Introduction to Internet of Things	3
EGRE 512	Intelligent Autonomous Systems	3
EGRE 513	Fundamentals of Modern Systems Engineering	3
EGRE 615	Systems Modeling	3
Total Hours		**30**

Concentration in tissue engineering and regenerative medicine

Thesis option

Course	Title	Hours
Required graduate-level coursework		
Engineering or other relevant graduate course work (including a minimum of 9 credit hours from 500-level or higher courses in EGRE, ENGR, EGRB, EGMN, CMSC, CLSE) approved by the advisory committee: This component allows the student to take courses in either engineering or science with approval of the student's adviser.		12
Concentration component - TERM course work		
EGRB 512	Regenerative Engineering and Medicine	3
EGRB 613	Biomaterials	3
EGRB 614	Tissue Engineering	3
EGRB 616	Cell Engineering	3
Directed research		
EGRB 697	Directed Research in Biomedical Engineering	6
Total Hours		**30**

Non-thesis option

Course	Title	Hours
Required graduate-level coursework		
Engineering or other relevant graduate course work (including a minimum of 9 credit hours from 500-level or higher courses in EGRE, ENGR, EGRB, EGMN, CMSC, CLSE) approved by the adviser: This component allows the student to take courses in either engineering or science with approval of the student's adviser.		15
Concentration component - TERM course work		

EGRB 512	Regenerative Engineering and Medicine	3
EGRB 613	Biomaterials	3
EGRB 614	Tissue Engineering	3
EGRB 616	Cell Engineering	3
Choose additional course work at the 500 level or higher		3
Total Hours		**30**

Recommended course sequence/plan of study

What follows is the recommended plan of study for students interested in the accelerated program beginning in the fall of the junior/senior year prior to admission to the accelerated program in the senior year.

Course	Title	Hours
Junior year		
Fall semester		
BIOL 151	Introduction to Biological Sciences I	3
CLSE 301	Transport Phenomena I	3
CLSE 305	Thermodynamics of Phase Equilibria and Chemical Reactions	3
UNIV 200	Advanced Focused Inquiry: Literacies, Research and Communication	3
Engineering elective (300+)		3
Term Hours:		15
Spring semester		
CLSE 302	Transport Phenomena II	4
CLSE 312	Chemical Reaction Engineering	3
CLSE 320	Instrumentation Laboratory	3
ECON 205	The Economics of Product Development and Markets	3
STAT 441	Applied Statistics for Engineers and Scientists	3
Term Hours:		16
Senior year		
Fall semester		
CLSE 402	Senior Design Studio I (Laboratory/ Project Time)	2
CLSE 409	Process Control in Chemical and Life Science Engineering	3
CLSE 440	Unit Operations Laboratory	3
ENGR 402	Senior Design Studio (Seminar)	1
ENGR 496	Internship Review	0
PHIL 201	Introduction to Ethics	3
Engineering elective - CLSE 5xx		3
Term Hours:		15
Spring semester		
ECON 101	Introduction to Political Economy	3
ENGR 403	Senior Design Studio (Seminar)	1
CLSE 403	Senior Design Studio II (Laboratory/ Project Time)	2
Engineering elective (300+ level)		3
Engineering elective - CLSE 5xx		3
Term Hours:		12

[1]

EGMN, EGRM, ENGR, EGRN, EGRB, EGRE, CLSE, CMSC, PHYS, MATH, NANO, CHEM, BIOL, GRAD, LFSC and OVPR at 500-level or above

Concentration in aerospace engineering

Course	Title	Hours
Fifth year		
Thesis option		
Fall semester		
Required graduate-level courses [1]		3
Concentration specific courses		6
EGMN 604	Mechanical and Nuclear Engineering Materials	
EGMN 605	Mechanical and Nuclear Engineering Analysis	
EGMN 606	Mechanical and Nuclear Engineering Continuum Mechanics	
EGMN 607	Heat and Mass Transfer Theory and Applications	
Directed research [2]		3
EGMN 697	Directed Research in Mechanical and Nuclear Engineering	
Term Hours:		12
Spring semester		
Required graduate-level courses [1]		3
Concentration specific courses		6
EGMN 604	Mechanical and Nuclear Engineering Materials	
EGMN 605	Mechanical and Nuclear Engineering Analysis	
EGMN 606	Mechanical and Nuclear Engineering Continuum Mechanics	
EGMN 607	Heat and Mass Transfer Theory and Applications	
Directed research [2]		3
EGMN 697	Directed Research in Mechanical and Nuclear Engineering	
Term Hours:		12
Non-thesis option		
Fall semester		
Required graduate-level courses [1]		3
Concentration specific courses		6
EGMN 604	Mechanical and Nuclear Engineering Materials	
EGMN 605	Mechanical and Nuclear Engineering Analysis	
EGMN 606	Mechanical and Nuclear Engineering Continuum Mechanics	

EGMN 607	Heat and Mass Transfer Theory and Applications	
EGMN 661	Computational Fluid Dynamics	
Term Hours:		9
Spring semester		
Required graduate-level courses [1]		3
Concentration specific courses		6
EGMN 604	Mechanical and Nuclear Engineering Materials	
EGMN 605	Mechanical and Nuclear Engineering Analysis	
EGMN 606	Mechanical and Nuclear Engineering Continuum Mechanics	
EGMN 607	Heat and Mass Transfer Theory and Applications	
EGMN 661	Computational Fluid Dynamics	
Term Hours:		9

[1]

Engineering or other relevant graduate course work (including a minimum of 9 credit hours from 500-level or higher courses in EGRE, ENGR, EGRB, EGMN, CMSC, CLSE) approved by the adviser. This component allows the student to take courses in either engineering or science with approval of the student's adviser.

[2]

This component emphasizes research directed toward completion of degree requirements under the direction of an adviser and advisory committee.

Concentration in chemical and life science engineering

Course	Title	Hours
Fifth year		
Thesis option		
Fall semester		
Required graduate-level courses [1]		3
Concentration specific courses		6
CLSE 650	Quantitative Analysis in Chemical and Life Science Engineering	
CLSE 654	Equilibrium Analysis in Chemical and Biological Systems	
CLSE 655	Nonequilibrium Analysis in Chemical and Life Science Engineering	
CLSE 656	Advanced Chemical Reaction Engineering	
Directed research [2]		3
CLSE 690	Research Seminar in Chemical and Life Science Engineering	
CLSE 697	Directed Research in Chemical and Life Science Engineering	
Term Hours:		12
Spring semester		
Required graduate-level courses [1]		3
Concentration specific courses		6
CLSE 650	Quantitative Analysis in Chemical and Life Science Engineering	
CLSE 654	Equilibrium Analysis in Chemical and Biological Systems	
CLSE 655	Nonequilibrium Analysis in Chemical and Life Science Engineering	
CLSE 656	Advanced Chemical Reaction Engineering	
Choose additional CLSE course work at the 500 level or higher		
Directed research [2]		3
CLSE 690	Research Seminar in Chemical and Life Science Engineering	
CLSE 697	Directed Research in Chemical and Life Science Engineering	
Term Hours:		12
Non-thesis option		
Fall semester		
Required graduate-level courses [1]		3
Concentration specific courses		6
CLSE 650	Quantitative Analysis in Chemical and Life Science Engineering	
CLSE 654	Equilibrium Analysis in Chemical and Biological Systems	
CLSE 655	Nonequilibrium Analysis in Chemical and Life Science Engineering	
CLSE 656	Advanced Chemical Reaction Engineering	
Term Hours:		9
Spring semester		
Required graduate-level courses [1]		3
Concentration specific courses		6
CLSE 650	Quantitative Analysis in Chemical and Life Science Engineering	
CLSE 654	Equilibrium Analysis in Chemical and Biological Systems	
CLSE 655	Nonequilibrium Analysis in Chemical and Life Science Engineering	
CLSE 656	Advanced Chemical Reaction Engineering	
Term Hours:		9

[1]

Engineering or other relevant graduate course work (including a minimum of 9 credit hours from 500-level or higher courses in EGRE, ENGR, EGRB, EGMN, CMSC, CLSE) approved by the adviser. This component allows the student to take courses in either engineering or science with approval of the student's adviser.

[2]

This component emphasizes research directed toward completion of degree requirements under the direction of an adviser and advisory committee.

Concentration in electrical and computer engineering

Course	Title	Hours
Fifth year		
Thesis option		
Fall semester		
Required graduate-level courses [1]		3
Concentration specifc courses [2]		6
Directed research [3]		3
EGRE 697	Directed Research in Electrical and Computer Engineering	
Term Hours:		12
Spring semester		
Required graduate-level courses [1]		3
Concentration specific courses [2]		6
Directed research [3]		3
EGRE 697	Directed Research in Electrical and Computer Engineering	
Term Hours:		12
Non-thesis option		
Fall semester		
Required graduate-level courses [1]		3
Concentration specific courses [2]		6
Term Hours:		9
Spring semester		
Required graduate-level courses [1]		3
Concentration specific courses [2]		6
Term Hours:		9

1

Engineering or other relevant graduate course work (including a minimum of 9 credit hours from 500-level or higher courses in EGRE, ENGR, EGRB, EGMN, CMSC, CLSE) approved by the adviser. This component allows the student to take courses in either engineering or science with approval of the student's adviser.

2

EGRE course work (EGRE 500-level or higher or courses approved by the advisory committee): This component allows the student to pursue a series of courses that focus on a specific field of engineering and serve as the student's primary engineering discipline.

3

This component emphasizes research directed toward completion of degree requirements under the direction of an adviser and advisory committee.

Concentration in engineering management

Course	Title	Hours
Fifth year		
Fall semester		
Required graduate-level courses [1]		3
Concentration specifc courses		6
EGMN 507	Law and Engineering	
ENGR 601	Engineering Project Management	
ENGR 602	Engineering Contracts and Effective Negotiations	
ENGR 696	Engineering Products and Economic Considerations	
Term Hours:		9
Spring semester		
Required graduate-level courses		3
Concentration specific courses		6
EGMN 507	Law and Engineering	
ENGR 601	Engineering Project Management	
ENGR 602	Engineering Contracts and Effective Negotiations	
ENGR 696	Engineering Products and Economic Considerations	

1

Engineering or other relevant graduate course work (including a minimum of 9 credit hours from 500-level or higher courses in EGRE, ENGR, EGRB, EGMN, CMSC, CLSE) approved by the adviser. This component allows the student to take courses in either engineering or science with approval of the student's adviser.

Concentration in environmental and sustainable engineering

Course	Title	Hours
Fifth year		
Thesis option		
Fall semester		
Required graduate-level courses [1]		3
Concentration specific		6
CLSE 545	Water Essentials	
CLSE 580	Sustainable Chemical Engineering	
CLSE 650	Quantitative Analysis in Chemical and Life Science Engineering	
CLSE 655	Nonequilibrium Analysis in Chemical and Life Science Engineering	
Directed research [2]		3
CLSE 697	Directed Research in Chemical and Life Science Engineering	
Term Hours:		12
Spring semester		
Required graduate-level courses [1]		3
Concentration specific courses		6
CLSE 545	Water Essentials	
CLSE 580	Sustainable Chemical Engineering	
CLSE 650	Quantitative Analysis in Chemical and Life Science Engineering	
CLSE 655	Nonequilibrium Analysis in Chemical and Life Science Engineering	
Directed research [2]		3
CLSE 697	Directed Research in Chemical and Life Science Engineering	
Term Hours:		12
Non-thesis option		

Fall semester		
Required graduate-level courses [1]		3
Concentration specific courses		6
CLSE 545	Water Essentials	
CLSE 580	Sustainable Chemical Engineering	
CLSE 650	Quantitative Analysis in Chemical and Life Science Engineering	
CLSE 655	Nonequilibrium Analysis in Chemical and Life Science Engineering	
Term Hours:		9
Spring semester		
Required graduate-level courses [1]		3
Concentration specific courses		6
CLSE 545	Water Essentials	
CLSE 580	Sustainable Chemical Engineering	
CLSE 650	Quantitative Analysis in Chemical and Life Science Engineering	
CLSE 655	Nonequilibrium Analysis in Chemical and Life Science Engineering	
Term Hours		9

1

Engineering or other relevant graduate course work (including a minimum of 9 credit hours from 500-level or higher courses in EGRE, ENGR, EGRB, EGMN, CMSC, CLSE) approved by the adviser. This component allows the student to take courses in either engineering or science with approval of the student's adviser.

2

This component emphasizes research directed toward completion of degree requirements under the direction of an adviser and advisory committee.

Concentration in rehabilitation engineering

Course	Title	Hours
Fifth year		
Thesis option		
Fall semester		
Required graduate-level courses [1]		3
Concentration specifc courses		6
EGRB 520	Assistive Technology	
EGRB 521	Human Factors Engineering	
EGRB 523	Rehabilitation Engineering and Prostheses	
EGRB 603	Biomedical Signal Processing	
ANAT 610	Systems Neuroscience	
Directed research [2]		3
EGRB 697	Directed Research in Biomedical Engineering	
Term Hours:		12
Spring semester		
Required graduate-level courses [1]		3
Concentration specific courses		6
EGRB 520	Assistive Technology	
EGRB 521	Human Factors Engineering	
EGRB 523	Rehabilitation Engineering and Prostheses	
EGRB 603	Biomedical Signal Processing	
ANAT 610	Systems Neuroscience	
Directed research [2]		3
EGRB 697	Directed Research in Biomedical Engineering	
Term Hours:		12
Non-thesis option		
Fall semester		
Required graduate-level courses [1]		3
Concentration specific courses		6
EGRB 520	Assistive Technology	
EGRB 521	Human Factors Engineering	
EGRB 523	Rehabilitation Engineering and Prostheses	
EGRB 603	Biomedical Signal Processing	
ANAT 610	Systems Neuroscience	
Term Hours:		9
Spring semester		
Required graduate-level courses [1]		3
Concentration specific courses		6
EGRB 520	Assistive Technology	
EGRB 521	Human Factors Engineering	
EGRB 523	Rehabilitation Engineering and Prostheses	
EGRB 603	Biomedical Signal Processing	
ANAT 610	Systems Neuroscience	
Term Hours:		9

1

Engineering or other relevant graduate course work (including a minimum of 9 credit hours from 500-level or higher courses in EGRE, ENGR, EGRB, EGMN, CMSC, CLSE) approved by the adviser. This component allows the student to take courses in either engineering or science with approval of the student's adviser.

2

This component emphasizes research directed toward completion of degree requirements under the direction of an adviser and advisory committee.

Concentration in systems engineering

Course	Title	Hours
Fifth year		
Thesis option		
Fall semester		
Required graduate-level courses [1]		3
Concentration specific courses		6
EGRE 510	Introduction to Internet of Things	
EGRE 512	Intelligent Autonomous Systems	
EGRE 513	Fundamentals of Modern Systems Engineering	

EGRE 615	Systems Modeling	
Directed research		3
EGRE 697	Directed Research in Electrical and Computer Engineering	
Term Hours:		12
Spring semester		
Required graduate-level courses [1]		3
Concentration specific courses		6
EGRE 510	Introduction to Internet of Things	
EGRE 512	Intelligent Autonomous Systems	
EGRE 513	Fundamentals of Modern Systems Engineering	
EGRE 615	Systems Modeling	
Directed research [2]		3
EGRE 697	Directed Research in Electrical and Computer Engineering	
Term Hours:		12
Non-thesis option		
Fall semester		
Required graduate-level courses [1]		3
Concentration specific courses		6
EGRE 510	Introduction to Internet of Things	
EGRE 512	Intelligent Autonomous Systems	
EGRE 513	Fundamentals of Modern Systems Engineering	
EGRE 615	Systems Modeling	
Term Hours:		9
Spring semester		
Required graduate-level courses [1]		3
Concentration specific courses		6
EGRE 510	Introduction to Internet of Things	
EGRE 512	Intelligent Autonomous Systems	
EGRE 513	Fundamentals of Modern Systems Engineering	
EGRE 615	Systems Modeling	
Term Hours		9

[1]

Engineering or other relevant graduate course work (including a minimum of 9 credit hours from 500-level or higher courses in EGRE, ENGR, EGRB, EGMN, CMSC, CLSE) approved by the adviser. This component allows the student to take courses in either engineering or science with approval of the student's adviser.

[2]

This component emphasizes research directed toward completion of degree requirements under the direction of an adviser and advisory committee.

Concentration in tissue engineering and regenerative medicine

Course	Title	Hours
Fifth year		
Thesis option		
Fall semester		
Required graduate-level courses [1]		3
Concentration specific courses		6
EGRB 512	Regenerative Engineering and Medicine	
EGRB 613	Biomaterials	
EGRB 614	Tissue Engineering	
EGRB 616	Cell Engineering	
Directed research [2]		3
EGRB 697	Directed Research in Biomedical Engineering	
Term Hours:		12
Spring semester		
Required graduate-level courses [1]		3
Concentration specific courses		6
EGRB 512	Regenerative Engineering and Medicine	
EGRB 613	Biomaterials	
EGRB 614	Tissue Engineering	
EGRB 616	Cell Engineering	
Directed research [2]		3
EGRB 697	Directed Research in Biomedical Engineering	
Term Hours:		12
Non-thesis option		
Fall semester		
Required graduate-level courses		3
Concentration specific courses		6
EGRB 512	Regenerative Engineering and Medicine	
EGRB 613	Biomaterials	
EGRB 614	Tissue Engineering	
EGRB 616	Cell Engineering	
Term Hours:		9
Spring semester		
Required graduate-level courses		
Concentration specific courses		
EGRB 512	Regenerative Engineering and Medicine	
EGRB 613	Biomaterials	
EGRB 614	Tissue Engineering	
EGRB 616	Cell Engineering	
Term Hours:		9

[1]

Engineering or other relevant graduate course work (including a minimum of 9 credit hours from 500-level or higher courses in EGRE, ENGR, EGRB, EGMN, CMSC, CLSE) approved by the adviser. This component allows the student to take courses in either engineering or science with approval of the student's adviser.

[2]

This component emphasizes research directed toward completion of degree requirements under the direction of an adviser and advisory committee.

Accelerated B.S. and M.S.

The accelerated B.S. and M.S. program allows qualified students to earn both the B.S. in Chemical and Life Science Engineering and the M.S.

in Mechanical and Nuclear Engineering in a minimum of five years by completing approved graduate courses during the senior year of their undergraduate program. Students in the program may count up to twelve hours of graduate courses toward both the B.S. and M.S. degrees. Thus, the two degrees may be earned with a minimum of 144 credits rather than the 156 credits necessary if the two degrees are pursued separately.

Students holding these degrees will have a head start for pursuing careers in industry or continuing in an academic setting. The M.S. degree provides formal research experience and can lead to expanded job opportunities, greater potential for job advancement and higher starting salaries.

Entrance to the accelerated program

Interested undergraduate students should consult with their adviser as early as possible to receive specific information about the accelerated program, determine academic eligibility and submit (no later than two semesters prior to graduating with a baccalaureate degree, that is, before the end of the spring semester of their junior year) an Accelerated Program Declaration Form to be approved by the graduate program director. Limited spaces may be available in the accelerated program. Academically qualified students may not receive approval if capacity has been reached.

Minimum qualifications for entrance to this accelerated program include a minimum overall GPA of 3.0. Students who are interested in the accelerated program should consult with the graduate program director. Successful applicants will enter the program in the fall semester of their senior year.

Once enrolled in the accelerated program, students must meet the standards of performance applicable to graduate students as described in the "**Satisfactory academic progress**" section of the Graduate Bulletin, including maintaining a 3.0 GPA. Guidance to students admitted to the accelerated program is provided by both the CLSE undergraduate program director and the CLSE graduate program director.

Admission to the graduate program

Entrance to the accelerated program enables the student to take the approved shared courses that will apply to the undergraduate and graduate degrees. However, entry into an accelerated program via an approved Accelerated Program Declaration Form does not constitute application or admission into the graduate program. Admission to the graduate program requires a separate step that occurs through a formal application to the master's program, which is submitted through Graduate Admissions no later than a semester prior to graduation with the baccalaureate degree, that is, before the end of the fall semester of the senior year. In order to continue pursuing the master's degree after the baccalaureate degree is conferred, accelerated students must follow the admission to graduate study requirements outlined in the VCU Bulletin. One reference letter from a chemical and life science engineering faculty member must accompany the application. The GRE is waived for admission to the program.

Degree requirements

The Bachelor of Science in Chemical and Life Science Engineering degree will be awarded upon completion of a minimum of 126 credits and the satisfactory completion of all undergraduate degree requirements as stated in the Undergraduate Bulletin.

A maximum of 12 graduate credits of 500-level graduate courses may be taken prior to completion of the baccalaureate degree. These graduate credits will be utilized to fulfill engineering electives course requirements for the undergraduate degree. These courses are shared credits with the graduate program, meaning that they will be applied to both undergraduate and graduate degree requirements.

The graduate courses that may be taken as an undergraduate, once a student is admitted to the program, must be approved by the adviser or graduate program director and include 500-level courses from the following subject areas: EGMN, EGRM, ENGR, EGRN, EGRB, EGRE, CLSE, CMSC, PHYS, MATH, NANO, CHEM, BIOL, GRAD, LFSC, INNO and OVPR.

Recommended course sequence/plan of study

What follows is the recommended plan of graduate study for students interested in the accelerated program beginning in the fall of the senior year.

For students pursuing the thesis option

Course	Title	Hours
Senior year		
Fall semester		
CLSE 402	Senior Design Studio I (Laboratory/ Project Time)	2
CLSE 409	Process Control in Chemical and Life Science Engineering	3
CLSE 440	Unit Operations Laboratory	3
ENGR 402	Senior Design Studio (Seminar)	1
ENGR 496	Internship Review	0
or ENGR 498	Review of Cooperative Education Experience	
PHIL 201	Introduction to Ethics	3
Approved technical electives (Consider MNE courses for accelerated pathway)		3
Term Hours:		15
Spring semester		
CLSE 403	Senior Design Studio II (Laboratory/ Project Time)	2
ENGR 403	Senior Design Studio (Seminar)	1
General education course		3
Approved technical electives (Consider MNE courses for accelerated pathway)		9
Term Hours:		15
Fifth year		
Fall semester		
EGMN 605	Mechanical and Nuclear Engineering Analysis	3
EGMN 606	Mechanical and Nuclear Engineering Continuum Mechanics	3
EGMN 610	Topics in Nuclear Engineering	3
Term Hours:		9
Spring semester		
EGMN 697	Directed Research in Mechanical and Nuclear Engineering	6
Technical electives (Select 600-level courses from: EGMN, EGRM, ENGR, EGRN, EGRB, EGRE, CLSE, CMSC, PHYS, MATH, NANO, CHEM, BIOL, GRAD, LFSC and OVPR.))		3
Term Hours:		9

For students pursuing the non-thesis option

Course	Title	Hours
Senior year		
Fall semester		
CLSE 402	Senior Design Studio I (Laboratory/ Project Time)	2
CLSE 409	Process Control in Chemical and Life Science Engineering	3
CLSE 440	Unit Operations Laboratory	3
ENGR 402	Senior Design Studio (Seminar)	1
ENGR 496	Internship Review	0
or ENGR 498	Review of Cooperative Education Experience	
PHIL 201	Introduction to Ethics	3
Approved technical electives (Consider MNE courses for accelerated pathway)		3
Term Hours:		15
Spring semester		
CLSE 403	Senior Design Studio II (Laboratory/ Project Time)	2
ENGR 403	Senior Design Studio (Seminar)	1
General education course		3
Approved technical electives (Consider MNE courses for accelerated pathway)		9
Term Hours:		15
Fifth year		
Fall semester		
EGMN 605	Mechanical and Nuclear Engineering Analysis	3
EGMN 606	Mechanical and Nuclear Engineering Continuum Mechanics	3
EGMN 610	Topics in Nuclear Engineering	3
Term Hours:		9
Spring semester		
EGMN 697	Directed Research in Mechanical and Nuclear Engineering	6
Technical electives (Select 600-level courses from: EGMN, EGRM, ENGR, EGRN, EGRB, EGRE, CLSE, CMSC, PHYS, MATH, NANO, CHEM, BIOL, GRAD, LFSC and OVPR.))		3
Term Hours:		9